

# Topic 16 Reproduction

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## 16.1 Asexual Reproduction

**Definition:** **Asexual reproduction** is a process that results in the production of **genetically identical offspring** from a **single parent**. It involves only one organism and no fusion of gametes.

**Examples of Asexual Reproduction:** Examples include binary fission in bacteria, budding in yeast, and vegetative propagation in plants (e.g., runners in strawberries, tubers in potatoes, bulbs in onions).

### Advantages and Disadvantages of Asexual Reproduction

| Context                       | Advantage   | Disadvantage   |
|-------------------------------|---|--|
| To a Population (in the wild) | <b>Rapid colonisation</b> of a stable environment. Only one parent is needed, making it efficient.  | <b>Lack of genetic variation</b> , making the entire population susceptible to a single disease or environmental change. |
| To Crop Production            | Guaranteed production of high-quality, <b>genetically uniform</b> crops (e.g., all bananas are identical). Faster maturity and <b>quicker yield</b> . | <b>High vulnerability</b> to a single pest or disease outbreak, which can <b>wipe out</b> the entire crop.               |

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## 16.2 Sexual Reproduction

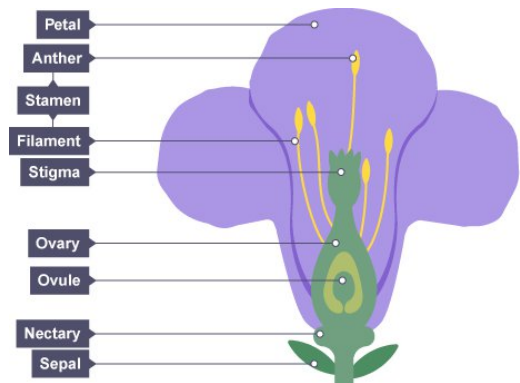
### Definitions:

- **Sexual reproduction** is a process involving the **fusion of the nuclei of two gametes** (sex cells) to form a **zygote**, producing **genetically different offspring**.
- **Fertilisation** is the process where the **nucleus of a male gamete fuses with the nucleus of a female gamete**.
- **Gametes** are the male and female sex cells (e.g., sperm and egg in animals, pollen nucleus and ovule nucleus in plants).
- **Zygote** is the single cell formed after fertilisation.

## 16.3 Sexual Reproduction in Plants

### Structure of a Flower

The flower is the reproductive organ of a plant. The syllabus requires identification and knowledge of the function of the following parts:



| Part             | Function  |
|------------------|---|
| Sepals           | Protect the flower bud before it opens.   |
| Petals           | Often large, brightly coloured, and scented to <b>attract insects</b> for pollination.            |
| Stamens          | The male reproductive part, consisting of the anther and filament.                                |
| ↳ Filament       | Stalk that holds the anther up.   |
| ↳ Anthers        | Produces and contains <b>pollen grains</b> (the male gametes).                                    |
| Carpels (Pistil) | The female reproductive part, consisting of the stigma, style, and ovary.                         |
| ↳ Stigma         | Sticky surface that <b>receives the pollen grains</b> .   |
| ↳ Style          | Stalk that connects the stigma to the ovary; the pollen tube grows down it.                       |
| ↳ Ovary          | Contains the <b>ovules</b> (which contain the female gametes). The ovary develops into the fruit. |
| Ovules           | Contain the female gametes and develop into <b>seeds</b> after fertilisation.                     |

## Structural Adaptations of Insect- and Wind-Pollinated Flowers

| Feature              | Insect-Pollinated Flower                                       | Wind-Pollinated Flower   |
|----------------------|--|--|
| <b>Petals</b>        | Large, brightly coloured, often scented.                       | Small, dull, or absent.  |
| <b>Nectaries</b>     | Present, producing nectar to reward insects.                   | Absent.  |
| <b>Pollen Grains</b> | Fewer in number, large, sticky, or spiky to attach to insects. | Large numbers, small, light, and smooth to be easily carried by the wind.                |
| <b>Anthers</b>       | Stiff and firmly attached, often inside the flower.            | Loose and dangling on long filaments, often outside the flower to release pollen easily. |
| <b>Stigma</b>        | Small, sticky, and often enclosed within the flower.           | Large, feathery, and exposed to catch pollen from the air.                               |

## Pollination and Fertilisation in Plants

- **Pollination** is the transfer of pollen grains from the anther to the stigma.
  - **Self-pollination:** Transfer of pollen from the anther to the stigma of the **same flower** or another flower on the **same plant**. (it relies less on pollinators and required less energy)
  - **Cross-pollination:** Transfer of pollen from the anther of one flower to the stigma of a flower on a **different plant** of the same species.

| Pollination Type         | Effect on Variation                                   | Effect on Population Adaptation  |
|--------------------------|---|--|
| <b>Self-pollination</b>  | Leads to <b>less genetic variation</b> (inbreeding).  | Less able to adapt to changes in the environment due to a lack of variation. (less resilience against disease) |
| <b>Cross-pollination</b> | Leads to <b>more genetic variation</b> (outbreeding). | More able to adapt to changes in the environment due to a wider gene pool.                                     |

- **Growth of the Pollen Tube and Fertilisation:**
  - 1 A pollen grain lands on the stigma.
  - 2 It germinates, growing a **pollen tube** down the style towards the ovary.
  - 3 The pollen tube enters the ovule through a small hole.
  - 4 The **pollen nucleus fuses with the nucleus in the ovule** (fertilisation).
  - 5 The fertilised ovule develops into a **seed**, and the ovary develops into a **fruit**.

## Seed Germination

**Seed germination** is the process by which a seed begins to grow into a new plant.

**Conditions for Seed Germination:** The three essential conditions for germination are:

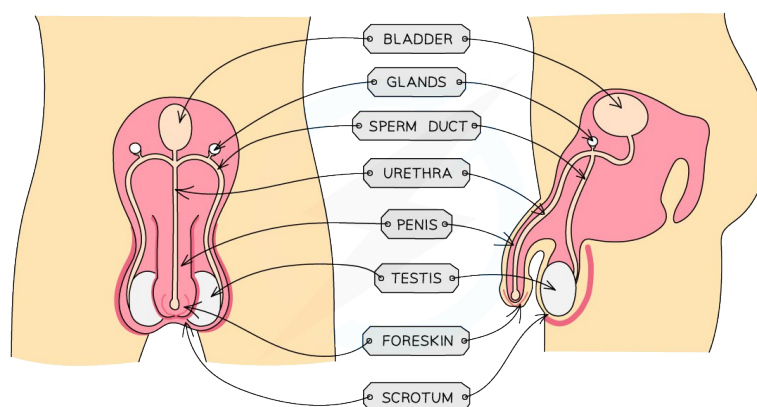
- 1 **Water:** To activate enzymes and transport dissolved food substances.
- 2 **Oxygen:** For aerobic respiration to release energy for growth.
- 3 **Suitable Temperature:** For the optimum activity of the enzymes involved in germination.

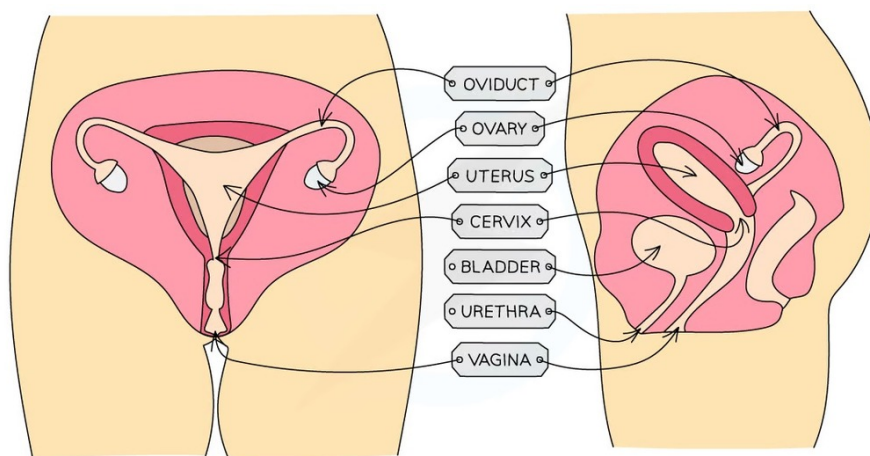
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## 16.4 Sexual Reproduction in Humans

### Structure and Function of the Reproductive Systems

| Part           | Male Reproductive System Function   |
|----------------|---|
| Testes         | Produce <b>sperm</b> (male gametes) and the hormone <b>testosterone</b> .   |
| Scrotum        | Sac that holds the testes outside the body, maintaining a temperature lower than body temperature for optimal sperm production. |
| Sperm Ducts    | Tubes that carry sperm from the testes to the urethra.  |
| Prostate Gland | Produces a fluid that mixes with sperm to form <b>semen</b> , providing nutrients and a fluid medium.                           |
| Urethra        | Tube that carries semen (and urine) out of the body through the penis.  |
| Penis          | Organ used to pass urine and transfer semen into the female vagina during sexual intercourse.                                   |





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| Part                       | Female Reproductive System Function   |
|----------------------------|---|
| Ovaries                    | Produce <b>egg cells</b> (ova, female gametes) and the hormones <b>oestrogen</b> and <b>progesterone</b> .      |
| Oviducts (Fallopian Tubes) | Tubes that carry the egg from the ovary to the uterus. <b>Site of fertilisation</b> .                           |
| Uterus (Womb)              | Muscular organ where the <b>fetus develops</b> during pregnancy.  |
| Cervix                     | Ring of muscle at the entrance to the uterus, keeping the fetus in place during pregnancy.                      |
| Vagina                     | Muscular tube leading from the cervix to the outside of the body; receives the penis during sexual intercourse. |
| Urethra                    | Carries urine out of the body   |

## Gametes and Fertilisation

- Fertilisation** is the fusion of the nucleus of a sperm with the nucleus of an egg (ovum) to form a **zygote**. This typically occurs in the **oviduct**.
- The **zygote** then divides repeatedly to form an **embryo**, which travels to the uterus and **implants** itself into the thickened uterine lining.

## Adaptive Features of Gametes

| Gamete     | Adaptive Features   |
|------------|---|
| Sperm      | <b>Flagellum (Tail):</b> For movement (motility) towards the egg. <b>Mitochondria:</b> Provide energy (ATP) for the tail's movement. <b>Enzymes (in acrosome):</b> Digest the outer layers of the egg cell to allow the sperm nucleus to enter. |
| Egg (Ovum) | <b>Large size:</b> Contains a large store of <b>energy/nutrients</b> for the initial development of the zygote/embryo. <b>Jelly Coat:</b> Changes structure after one sperm enters to prevent other sperm from entering ( <b>polyspermy</b> ).  |

## Comparison of Male and Female Gametes

| Feature   | Sperm (Male Gamete)                                   | Egg (Female Gamete)                                  |
|-----------|---|--|
| Size      | Very small.   | Very large (largest cell in the body).               |
| Structure | Head, mid-piece (mitochondria), and flagellum (tail). | Spherical, surrounded by a jelly coat.               |
| Motility  | Motile (can move).                                    | Non-motile (cannot move on its own).                 |
| Numbers   | Produced in very large numbers (millions).            | Produced in small numbers (one per menstrual cycle). |

## Development of the Fetus

After implantation, the embryo develops into a **fetus**. The fetus is supported by several structures:

| Structure      | Function   |
|----------------|--|
| Placenta       | Organ that allows the exchange of substances between the mother's blood and the fetus's blood, it also produces progesterone during pregnancy.   |
| Umbilical Cord | Connects the fetus to the placenta, containing blood vessels that transport substances to and from the fetus.  |
| Amniotic Sac   | Membrane that encloses the fetus.  |
| Amniotic Fluid | Fluid inside the amniotic sac that surrounds the fetus. Its functions are to: 1. Act as a <b>shock absorber</b> to protect the fetus from mechanical injury. 2. Maintain a <b>constant temperature</b> for the fetus. 3. Allow the fetus <b>freedom of movement</b> for muscular and skeletal development. |

## Function of the Placenta and Umbilical Cord (Exchange of Substances)

The placenta facilitates the exchange of substances between the mother's blood and the fetus's blood via diffusion, **without the bloodstreams mixing**.

- **Substances passing from Mother to Fetus:**
  - **Dissolved nutrients** (e.g., glucose, amino acids, vitamins).
  - **Oxygen** (for respiration).
  - **Antibodies** (for passive immunity).
- **Substances passing from Fetus to Mother (Excretory Products):**
  - **Carbon dioxide**.
  - **Urea** and other metabolic wastes.

**Harmful Substances Crossing the Placenta:** The placenta is not a perfect barrier. Some **pathogens** (e.g., the virus that causes Rubella, or HIV) and **toxins** (e.g., alcohol, nicotine from smoking, certain drugs) can pass across the placenta and affect the fetus, potentially causing birth defects or miscarriage.

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## 16.5 Sex Hormones in Humans

### Role of Hormones

- **Testosterone (Male Hormone):**
  - Causes the development of the **male primary sexual characteristics** (development of testes and penis).
  - Causes the development of **male secondary sexual characteristics** at puberty (e.g., growth of facial and body hair, deepening of the voice, increased muscle mass, sperm production).
- **Oestrogen (Female Hormone):**
  - Causes the development of the **female primary sexual characteristics** (development of ovaries, oviducts, and uterus).
  - Causes the development of **female secondary sexual characteristics** at puberty (e.g., widening of hips, development of breasts, onset of the menstrual cycle).
  - Plays a crucial role in regulating the **menstrual cycle**.

### The Menstrual Cycle

The menstrual cycle is controlled by four key hormones: Follicle-Stimulating Hormone (FSH), Luteinising Hormone (LH), Oestrogen, and Progesterone. FSH and LH are produced by the **pituitary gland** in the brain, while Oestrogen and Progesterone are produced by the ovaries.

The menstrual cycle is a monthly cycle of changes in the female reproductive system, typically lasting about 28 days.

| Days             | Changes in the Uterine Lining   | Changes in the Ovaries  |
|------------------|---|---|
| Days 1–5         | <b>Menstruation</b> (period): The thickened uterine lining breaks down and is shed. <b>Hormone Levels:</b> The pituitary gland secretes <b>FSH</b> , which stimulates an ovarian follicle to start maturing. Oestrogen and Progesterone levels are low.             | A new egg begins to mature in an ovarian follicle, stimulated by FSH.   |
| Days 6–13        | The uterine lining starts to <b>thicken again</b> and becomes richly supplied with blood vessels. <b>Hormone Levels:</b> Rising <b>Oestrogen</b> (produced by the developing follicle) stimulates the repair and thickening of the uterine lining + inhibiting FSH. | The egg continues to mature within the follicle.  |
| Day 14 (approx.) | -   | <b>Ovulation:</b> The mature egg is released from the ovary into the oviduct. <b>Hormone Levels:</b> A surge in <b>Luteinising Hormone (LH)</b> triggers ovulation. |
| Days 15–28       | The uterine lining continues to thicken, maintained by <b>Progesterone</b> (produced by the Corpus Luteum), ready for implantation. If no fertilisation occurs, the corpus luteum degenerates, Progesterone levels drop, and the cycle restarts.                    | The empty follicle develops into the <b>Corpus Luteum</b> , which produces <b>Progesterone</b> and some Oestrogen.  |

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## 16.6 Sexually Transmitted Infections (STIs)

**Definition:** A **Sexually Transmitted Infection (STI)** is an infection that is transmitted from an infected person to an uninfected person through **sexual contact**, including intercourse.

### HIV/AIDS:

- **HIV (Human Immunodeficiency Virus)** is a **pathogen** that causes an STI.
- HIV attacks and destroys the white blood cells (lymphocytes) of the immune system, leading to **AIDS (Acquired Immunodeficiency Syndrome)**.
- AIDS is the final stage of HIV infection, where the immune system is severely compromised, making the person vulnerable to opportunistic infections and cancers.

**Methods of HIV Transmission:** HIV is transmitted through the exchange of certain body fluids:

- 1 **Unprotected sexual intercourse .**
- 2 **Sharing of contaminated needles** (e.g., by drug users).
- 3 **Blood transfusions** with infected blood (rare in countries with screening).
- 4 **From an infected mother to her child** (during pregnancy, birth, or breastfeeding).

**Control of STIs (including HIV):** The spread of STIs can be controlled by:

- 1 **Abstinence:** Avoiding sexual intercourse.
- 2 **Using barrier methods:** Such as **condoms**, which prevent the exchange of body fluids.
- 3 **Reducing the number of sexual partners** (monogamy).
- 4 **Screening and treatment** of infected individuals and their partners.
- 5 **Education and awareness** campaigns about safe sexual practices and transmission routes.
- 6 **Antenatal screening** of pregnant women for HIV and other STIs.